



2016 Partners & Sponsors		. 2
		. 4
Executive Summary.		. 5
2015 James D. Watkins Award for Excellence in Research Student Winners		. 6
Opening Plenary		. 7
Session Descriptions & Summaries (Grouped by topic)		. 8
Oil Breakdown & Transport		. 9
Long-term Fate & Impacts		10
Ecology, Ecosystem Services & Related Methodologies		11
Public Health & Socioeconomics		12
Data Management, Modeling & Decision-making		13
Attendance and Demographics		39
Appendix I: Conference Agenda		40
Appendix II: Associated Workshops & Meetings		42
Appendix III: Press Coverage Summary Report		45

1





















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The Gulf of Mexico region is a complex ecosystem in which the health and economic well-being of human communities is often inextricably connected with the 'health' of this unique basin. As new programs, and therefore new data, supporting the restoration of Gulf habitats and ecosystems come online, there is an increased need for the ability to share, integrate and analyze data from diverse sources, across disciplines and from varied spatial and temporal scales. The 2016 conference theme, "One Gulf: Healthy ecosystems, healthy communities," sought a more comprehensive understanding of the functioning of and connections between human and ecological systems, and exploring how research can better inform decisions that promote sustained and resilient ecosystem goods and services.

GULF OF MEXICO OIL SPILL & ECOSYSTEM SCIENCE CONFERENCE EXECUTIVE COMMITTEE

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Denis Wiesenburg, Gulf of Mexico Research Initiative

THE EXECUTIVE COMMITTEE THANKS THE FOLLOWING PARTNER ORGANIZATIONS FOR THEIR TIME AND SUPPORT:

The Gulf of Mexico Research Initiative Management Team provided logistical and programmatic support throughout the conference.

NOAA's Coastal Services Center provided pre-conference agenda development and onsite assistance with session summaries.

Volunteers from the University of South Florida and Eckerd College assisted with onsite registration and check-in.

EXECUTIVE SUMMARY: CONFERENCE OVERVIEW

The organizers, sponsors and participants of the Gulf of Mexico Oil Spill and Ecosystem Science Conference share the common goal to improve society's ability to understand the Gulf of Mexico, from its ecosystems to its people, and ensure the region's long-term health and resiliency. An important aspect of this goal is to understand the impacts of petroleum pollution and related stressors on marine and coastal ecosystems and on coastal populations, and to apply that information to improve future response, mitigation, and restoration following spills. Each year since the conference's inception in 2013, researchers have gathered together to share what they learned and identify what other work needs to be done. Themes from previous years include:

- Collaboration, integration and synthesis (2014)
- What have we learned, what does it mean and how can it be used? (2015)

This year's conference theme, "One Gulf: Healthy ecosystems, healthy communities," focused on opportunities to promote and sustain a healthy Gulf environment, communities, and economy. To complement the ecosystem science research that has led past conferences, the <u>2016 conference</u> placed a strong emphasis on the human dimensions of oil spills, as well as opportunities presented by the increasingly data-rich environment for informing decisions about the management of Gulf systems.

Sessions considered linkages between physicochemical processes and the health of people, animals, and Gulf ecosystems and understanding how research findings can inform decision-making that supports the health and well-being of Gulf communities and ecosystems.

The conference was planned by an Executive Committee of twelve partners from academia, federal agencies and non-governmental organizations, with the generous support of eight sponsors.

An overview of the conference schedule is available in Appendix I (page 40). Program highlights include:

- Keynote address by Dr. Marcia McNutt, Editor-in-Chief of Science;
- A panel discussion of challenges and opportunities presented by the changing data landscape;
- Eighteen conference sessions offering approximately 280 oral and 240 poster presentations on the ecosystem and human impacts of oil spills;
- Closing plenary session for the presentation of session summaries, demonstrating how the research
 presented contributes to a healthy, sustainable and resilient Gulf of Mexico; and
- A special "red carpet" screening of the documentary Dispatches from the Gulf, featuring oil spill scientists and their research in the region.

The conference also hosted fourteen associated meetings and events during the week, offering attendees the opportunity to learn about and discuss interdisciplinary topics not covered during the breakout sessions, such as disaster response preparedness, ocean observing, communications and outreach, and strategic partnerships. A summary of each meeting and its outcomes is provided in Appendix II (*page 42*).

Scientific Sessions

Sessions supported interdisciplinary dialogue on research implications, applications, and synthesis, with time dedicated to how research will 1) influence policy, conservation, restoration and management and 2) enhance public understanding of the Gulf of Mexico ecosystem. In keeping with the integrative theme for this year's conference, the Conference Executive Committee selected sessions to reflect a balance of the following topics:

- Oil breakdown and transport
- Long-term fate and impacts
- Ecology, ecosystem services and related methodologies
- Public health and socioeconomics
- Data management, modeling and decision-making

Highlight findings based on sessions and plenaries include:

- Droplet size is key to understanding the trajectory and fate of hydrocarbons.
- Evidence exists for Marine Oil Snow Sedimentation and Flocculent Accumulation (MOSSFA) events associated with other oil spills, as well as natural oil sedimentation at seeps.
- Issues related to baselines, vulnerability, risk, resilience, and recovery are important to understanding human and environmental systems, and to understanding impacts of oil spills on these often deeply interconnected systems.
- Research into the human dimensions of oil spills have revealed similar patterns of effects that extend beyond micro-level impacts at the individual level to macro-level effects in social, economic and political structures.
- The context of Gulf restoration is embedded within the influences of the Mississippi River and local watersheds, global climate change, and sea level rise.
- Ultimately, the community is creating a network of response systems that can address common questions related to the interconnectedness of disaster behavioral, environmental, and social health principals and overall disaster response capacity.

Science gaps and challenges identified by the sessions and plenaries include:

- Ensuring long-term monitoring and availability of special application databases and tools across programs and decades without loss of access or information is a challenge.
- Syntheses of research within and across spills could help build a knowledge base that improves response and restoration capabilities for future spills.
- Funding needs to be made available for several research goals.
- Making management decisions in the absence of basic baseline data is challenging.
- There is a lack of understanding the complexities of scaling up from individual level effects to population and ecosystem or societal level effects.
- Several questions remain about the long-term fate and impact of oil.
- Better communication is needed to link new research and findings to policy and management decisions.

Abstracts for <u>oral</u> and <u>poster</u> sessions are archived online and are available for viewing. Full session summaries and more detailed synthesis are available in the report (<u>pages 8-39</u>).

James D Watkins Student ²⁰¹⁶ str Award for ^{of} Excellence ⁱⁿ Research

Two students were recognized with the James D. Watkins Student Award for Excellence in Research for outstanding student presentations at the 2016 Gulf of Mexico Oil Spill and Ecosystem Science Conference. The award strives to recognize outstanding research in order to cultivate the next generation of ocean scientists and encourage excitement for presenting their work.

The Student Award for Excellence in Research is named after Admiral James D. Watkins, a hero in the ocean community who passed away in 2012. Admiral Watkins lived a life of public service and his extraordinary influence on the ocean science community is immeasurable. Given Admiral Watkins' lifelong

pursuit of encouraging and building the next generation of ocean scientists, it was most appropriate to name this award after him, as it recognizes excellent research as a way of motivating students to continue to excel in the field of oceanography.

The student recipients are:

- **Meredith Evans (The University of Texas at Austin, Marine Science Institute):** Evaluation of Chemical Weathering following the Deepwater Horizon Oil Spill in Louisiana Salt Marshes using Ramped Pyrolysis Gas Chromatography Mass Spectrometry (*Abstract available online*)
- **Danielle Simning (The University of Southern Mississippi):** Synergistic Effects of Deepwater Horizon Source Oil Exposures and Suboptimal Environmental Conditions during Early Life Development Stages in Sheepshead Minnow (*Cyprinodon variegatus*) (*Abstract available online*)

OPENING PLENARY

BIG, OPEN DATA: ENHANCING SCIENCE AND DECISION-MAKING FOR THE GULF OF MEXICO

"One Gulf: Perspectives on Environmental and Health Data for Advancing Science and for Informed Decision-Making"

Opening Plenary Keynote

Dr. Marcia McNutt, Editor-in-Chief of Science

Dr. McNutt stressed the increasing importance of transparency and openness in data access and sharing. While proponents see this movement as steady progress that is transforming science across multiple disciplines, one major journal recently published a number of concerns and proposed collaboration with original authors as a condition on using data. Because the use of original data for replicability is very important to field research, the scientific community would benefit more by setting up data repositories so that authors may come up with their own conclusions. *Science* has introduced Transparency and Openness Promotion (TOP) Standards which apply to both samples and data. With the support from a large number of other scientific journals, *Science* is leading the charge for publications' data to be made available in a repository with a DOI for citation.

Dr. McNutt's address is available on YouTube.

Discussion Panelists:

- Dr. Peter Brewer, Senior Scientist, Monterey Bay Aquarium Research Institute (moderator)
- Dr. Brooks Hanson, Director of Publications, American Geophysical Union
- Dr. Donald A.B. Lindberg, Director Emeritus, National Library of Medicine, NIH
- Dr. Robert Gropp, Interim Co-Executive Director, American Institute of Biological Sciences
- Dr. Lisa DiPinto, Senior Scientist for NOAA's Assessment and Restoration Division

The 2016 conference theme, "One Gulf: Healthy ecosystems, healthy communities," describes the goal of moving to a more comprehensive understanding of the functioning of and connections between human and ecological systems. Our ability to assess the 'health' of Gulf of Mexico ecosystems and human communities, and to ensure improvements over the long-term, requires the generation of and access to a wide array of data. The ways scientists gather, manage and analyze data are changing. While this creates incredible opportunities for conducting innovative research, supporting improved decision-making, and providing new documentation of earth and life systems that will drive discovery for decades to come, our emerging data rich environment raises important questions we must collectively resolve. Panelists discussed with the audience the challenges and opportunities presented by this changing data landscape for bridging the gulf between research on ecosystems and human communities, as well as for the increased use of data for informed decision-making. This discussion set the stage for conference sessions that highlighted research on the ecosystem and human impacts of oil spills.

Watch the panelists' opening remarks and the full panel discussion on YouTube.

SESSION DESCRIPTIONS & SUMMARIES

Following the opening plenary, the conference broke into half-day and full-day concurrent sessions. Over three days, 280 oral and 240 poster presentations (including 42 oral and 120 poster presentations given by students) discussed recent findings and advances in oil spill research. Summaries for the eighteen selected sessions are presented in one of five overarching tracks:

- Oil breakdown and transport
- Long-term fate and impacts
- Ecology, ecosystem services and related methodologies
- Public health and socioeconomics
- Data management, modeling and decision-making

Each track highlights key messages, as well as research gaps and challenges. Thank you to the session organizers for providing these summaries.

OIL BREAKDOWN AND TRANSPORT

Sessions

- Determination of the Oil Droplet Size Distribution and Its Impact on the Fate and Transport of Oil: Consequences on Public Health and Ecology
- Physical and Biological Processes of Oil Droplet Dispersion, Transport, Sedimentation and Biodegradation
- Oceanographic Controls of Oil Transport and Microbial Hydrocarbon Biodegradation in the Water Column: from the Surface to the Deepsea
- The Chemistry of Oil Evolution and Exopolymeric Substances and their Interaction with Microbes in Oil Spills

Overarching Highlights

- A new conceptual picture of oil and gas release into the ocean with a new focus on turbulence kinetic energy has emerged, which now includes vortex structures in the plume, gas bubble generation and interaction, and ocean currents.
- Droplet size is key to understanding the trajectory and fate of hydrocarbons.
 - Oil could leave the water column through binding with sediments (oil particle aggregates) and as aerosols.
 - Small droplets (< 100-200 μm) are critical and contribute to enhanced biodegradation rates.
 - Surfactants can increase the formation of nanometer-size oil droplets that when aerosolized may pose health risks. But surfactants tend to reduce the presence of volatile organic compound (VOC) immediately above the oil slick/blowout.
- There is evidence for MOSSFA events associated with other oil spills as well as natural oil sedimentation at seeps.
 - Research is demonstrating the role of exopolymeric substances in initiating formation of marine snow and their role in biogeochemical cycles.
 - o Both processes would be altered by oil plus dispersant.
 - Aggregation and dispersion of Oil-Aggregates is both stimulated and disrupted by the application of dispersant a tale of two contradictory stories.
 - More research is needed on the role of microbial (bacteria, archaea, phytoplankton) communities in the development of marine snow, how their role is influenced by oil, and vice versa.
 - o Different types of phytoplankton produce different kinds of expolymeric substances.
 - o Different types of oils elicit different responses in the microbial communities.
- This highlights the importance of less understood physical processes in the benthic boundary layer for constraining transport, mixing, and sedimentation.
 - What is the role of oiled marine snow formation under different clay particle regimes, oil types and phytoplankton types?

- Testing under deep water conditions and advanced models is needed.
 - Laboratory experiments need to improve large-scale testing and quantification of rates and processes under close-to-*in situ*-conditions for numerical modeling.
 - Models need to simultaneously describe oil and gas release as well as integrate other thermodynamic processes such as gas evolution.
- A better understanding of natural oil degradation and transport processes and how dispersants affect these processes is necessary.
- The toxicity of weathered and oxygenated hydrocarbons is unknown, and it is difficult to collect sufficient quantities of these oxygenated hydrocarbons to test toxicity.

DETERMINATION OF THE OIL DROPLET SIZE DISTRIBUTION AND ITS IMPACT ON THE FATE AND TRANSPORT OF OIL: CONSEQUENCES ON PUBLIC HEALTH AND ECOLOGY

Michel Boufadel, New Jersey Institute of Technology Robyn Conmy, U.S. Environmental Protection Agency Thomas King, Bedford Institute of Oceanography Kenneth Lee, Commonwealth Scientific and Industry Research Organization (CSIRO)** Joseph Katz, Johns Hopkins University**

Session Overview

The Deepwater Horizon blowout revealed that knowledge of the droplet size distribution (DSD) is crucial for evaluating the fate and transport of oil. Reproducing DWH conditions to estimate the DSD from the spill is not possible experimentally and even numerically, especially when dispersants are used. For this reason, researchers have developed approaches to capture salient aspects of the blowout, such as high pressure, high temperature, mixing energy, or the balance between turbulence forces and interfacial tension forces (i.e., the Weber number). In parallel, research has been conducted to quantify the oil DSD in waves, and the subsequent transport of oil in the water or in the atmosphere. This session focused on determining DSD and its impact on the fate and transport of oil, which is important for improving oil transport models, quantifying damage assessment and guiding restoration efforts.

Session Highlights

- Droplet size distribution is key to understanding the trajectory and fate of hydrocarbons.
- Oil could leave the water column through binding with sediments (OPA) and as aerosols.
- Surfactants can increase the formation of nm-size oil droplets that when aerosolized may pose health risks. But surfactants tend to reduce the VOC immediately above the oil slick/blowout.
- Advances in detection technologies, such as imaging, acoustic, backscattering, and fluorescence.

- Detection of oil in the field
- Large-scale testing
- Testing under deep water conditions and advanced models are needed.

PHYSICAL AND BIOLOGICAL PROCESSES OF OIL DROPLET DISPERSION, TRANSPORT, SEDIMENTATION AND BIODEGRADATION

Zachary Aman, University of Western Australia Jian Sheng, Texas Tech University Joseph Katz, Johns Hopkins University Michael Schlüter, Hamburg University of Technology Michel Boufadel, New Jersey Institute of Technology** **Invited Speaker

Session Overview

This session focused on experimental, multi-physics computational fluid dynamics (CFD), multi-phase hydrocarbon modeling-based studies, and their coupling to far-field models necessary to predict the distribution of crude oil under high pressure and cold water conditions and to enhance the accuracy and extend the applicability of Lagrangian simulators in these extreme conditions. It brought together academic, federal and industrial researchers to explore two main sub-themes: (i) breakup, dispersion, agglomeration and transport of oil, including subsea and surface hydrodynamic processes; (ii) interfacial interaction of microbes, plankton, and surfactants at the oil-water boundary.

Oil droplet dispersion controlled by turbulence and interfacial tension

- Simultaneous gas bubble generation *significantly* enhances turbulent mixing
- 'Live' oil properties (saturated w/gas) must be considered

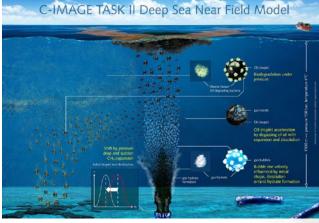
Small droplets (< 100-200 µm) are critical

- Natural sequestration by jet and/or currents
- Enhanced biodegradation rates

Session Highlights

- Development of new conceptual picture
- New focus on turbulence kinetic energy
 - Vortex structures in the plume, gas bubble generation and interaction, ocean currents
- Provides a roadmap to connect distributed lab and field geometries
 - Where and when oil may reach the surface
 - Whether dispersants should be considered
 - Biodegradation rates

- Simultaneously modelling gas and oil release
- Gas hydrate nucleation and growth rate
- Integrating thermodynamics (gas evolution)
- Biodegradation with surfactants at the interface
- Range of laboratory/field scale turbulence
- Range of fluid properties tested



C-IMAGE, 2016

OCEANOGRAPHIC CONTROLS OF OIL TRANSPORT AND MICROBIAL HYDROCARBON BIODEGRADATION IN THE WATER COLUMN: FROM THE SURFACE TO THE DEEPSEA

Joel Kostka, Georgia Institute of Technology Annalisa Bracco, Georgia Institute of Technology Claire Paris, University of Miami** **Invited Speaker

Session Overview

This session sought to synthesize information from a range of disciplines (physics, biology, chemistry) to improve our understanding of how prevailing oceanographic conditions determine the fate and transport of oil in the water column. It brought together scientists to uncover barriers to effective parameterization of oil plume models- focusing on physical and biogeochemical processes. The research presented provided a unique opportunity to develop a coherent picture of physical and biogeochemical coupling in benthic boundary layer to improve predictive models. New capabilities (observations, experiments, modeling) for constraining biodegradation and fate of petrocarbon across temperature/pressure/nutrient gradients were also discussed.

Session Highlights

- Mixing 'patchiness' in both space and time at the surface and near the bottom
- Importance of less understood physical processes in the benthic boundary layer for constraining transport, mixing, and sedimentation
- First measurements on radiocarbon signature of dissolved organic carbon
- Implications for planktonic food web such as availability of petrocarbon for microbial consumption or release from grazers
- Data from new laser sensors for CH4
- Oil-derived material sedimented to seafloor at seeps
- Biodegradation rates controlled more by nutrients than temperature

- Need to improve understanding of diapycnal mixing processes such as role of submesoscale structures, near-inertial waves and tidal waves, their spatial and temporal variability in top and bottom boundary layers
- Need for better parameterizations of physical processes in benthic boundary layer
- Need to improve quantification of rates and processes under close to in situ condition for numerical modeling

THE CHEMISTRY OF OIL EVOLUTION AND EXOPOLYMERIC SUBSTANCES AND THEIR INTERACTION WITH MICROBES IN OIL SPILLS

Jeff Chanton, Florida State University Antonietta Quigg, Texas A&M University Ryan Rodgers, National High Magnetic Field Laboratory** Monica Orellana, University of Washington** Uta Passow, University of California, Santa Barbara** **Invited Speaker

Session Overview

This session brought together those interested in the molecular-level chemistry and evolution of the structure, properties and transformation products of petroleum with those interested in the chemical and physical properties of the exopolymeric substances produced by microbes in response to the petrocarbon and dispersant. The type of exopolymeric substances and the composition of the evolving microbial community have been demonstrated to influence oil/dispersant fate and transport; however, the relationship whereby the environmental factors influence community composition and production of exopolymeric substances, micro-gels, and transparent exopolymer particles play in the fate of oil and the dispersant. This session brought together ecosystems and impacts which will serve to help us link to people in the future.

Session Highlights

- Role of microbial (bacteria, archaea, phytoplankton) communities on development of marine snow, how that's influenced by oil and vice versa
 - Different types of phytoplankton produce different kinds of expolymeric substances
 - Different types of oils elicit different responses in the microbial communities
 - Exopolymeric substance (micro-gels) formation could nucleate cloud formation
- As oil weathers, increases oxygen content, which increases its water solubility, with unknown effects on the above
- Forensic analysis reveals carbohydrate events different times, different times
- · Isolating specific fractions of the oxygenated water soluble weathered oil and test its toxicity
- Making more stable dispersants we can add less, we apply it more precisely, protect ecosystem and people
- Revealing marine snow formation increasing burial of oil to the deep removing it from surface waters (and people)
- Aggregation and dispersion of Oil-Aggregates is both stimulated and disrupted by the application of dispersant – a tale of two contradictory stories
- Evidence for MOSSFA events associated with other oil spills as well as natural oil sedimentation at seeps
- Probing influences of weathered oil and its derivatives on MOSSFA

- Toxicity of weathered and oxygenated hydrocarbons is unknown
- Collecting sufficient quantities of these oxygenated hydrocarbons to test toxicity
- Role of oiled marine snow formation under different clay particle regimes, oil types and phytoplankton types
- Role of exopolymeric substances in nucleating cloud formation and role in biogeochemical cycles which would be altered by oil plus dispersant

LONG-TERM FATE AND IMPACTS

Sessions

- The Evolution of the Deepwater Horizon Oil Spill: Updates on Fate and Transport of the Oil
- Extending the Use of Information from Oil Spills: Synthesis and Application of Research and Observations from Regions along the U.S. Outer Continental Shelf
- A Tale of Two (Mega) Spills: Comparison of DWH and IXTOC-1 Scenarios, Fates and Effects

Overarching Highlights

- Use of "Big Data" approaches in combination with research investigation-based data sets is the key approach to full understanding.
 - Synthesis of DWH knowledge should not be done in isolation of what is already known and what we need to know for future response; we need to look at other, smaller spills.
 - The uses of larger data sets (NOAA, BP) can be expanding since much of the data is directly transferable to posing questions, focusing environmental monitoring, optimizing data uses, and integration of new technologies.
- Reproducibility actually can happen (and for the most part did happen water and sediment data; fingerprinting methods).
 - Reproducibility of interpretations of same data sets was tested and found to be feasible and largely accomplished (but there are challenges).
- Observations are best paired with rigorous analytical chemical fingerprinting, but the latter have limitations.
 - This provides key starting points for defining initial exposures to oil and duration/persistence and determining the potential for long-term harm or lack thereof.
 - It also reaffirms the resiliency and capacity of the Gulf to naturally respond to spills via microbial degradation and other natural processes.
 - Issues related to baselines, vulnerability, risk, resilience, and recovery are important to understanding human and environmental systems, and to understanding impacts of oil spills on these often deeply interconnected systems.
 - Sociological and socio-economic impacts and consequence to coastal communities resulting from a mega oil spill need to be evaluated relative to various cultural norms and local traditions.
 - Baseline knowledge of ecosystems and human communities is critical for understanding oil spill impacts and the effectiveness of restoration and recovery efforts. It is important to remember that baselines are dynamic and need to inform causal analyses that take into account multiple stressors.
 - Research into the human dimensions of oil spills have revealed similar patterns of effects that extend beyond micro-level impacts at the individual level to macro-level effects in social, economic and political structures.
 - Fewer mechanisms exist for assessing and addressing impacts on human systems through regulatory mechanisms, environmental and social indices and research effort and capacity.
 - Net Environmental Benefit Analysis (NEBA) for spill response decision making is an integrative approach that seeks to incorporate both human and environmental impacts.

- MOSSFA processes are recorded during both the IXTOC and DWH events and are likely associated with future sub-marine blowouts.
 - MOSSFA processes recorded in sediments from the IXTOC event are similar to those observed in the nGoM region from the DWH blowout.
 - Weathering and biodegradation of oil greatly accelerated attenuation of harmful exposures.
 - Because MOSSFA events have long lasting impacts on the marine benthos, they can compromise the health sustainability and resilience of the Gulf.
 - MOSSFA events may be directly related to response strategies and therefore should be taken into consideration when response efforts are designed.

- Syntheses of research within and across spills could help build a knowledge base that improves
 response and restoration capabilities for future spills.
 - A collaborative approach that has crossed disciplines, sectors, and involved communities has been critical to ongoing Exxon Valdez Oil Spill research and monitoring and presents a model for long term DWH work.
 - Capturing the broad array of historical data, much of which has been collected but not published by academics, government and industry will greatly enhance this process.
- Gaps and disconnects exist between findings from "traditional" geochemical methods and "research biogeochemical methods" (e.g., location and amount of oil on the sea bottom), as do inconsistencies in oil source identification approaches.
- Carrying the fate and transport findings forward to address exposure and ecosystem health questions (the "so what" questions; e.g., What may be the future effects of residual oil in the marshes or oil remnants on the sea bottom?) is essential.
- Funding needs to be made available for assessing human dimensions of oil spills (including
 physical and mental health impacts on individuals and social, cultural, and economic impacts on
 communities) and for developing strategies that reduce harms of oil spills and enhance the resilience
 of communities.
 - Improved indices of recovery for both human communities and environmental resources are needed to inform NEBA analyses.

THE EVOLUTION OF THE DEEPWATER HORIZON OIL SPILL: UPDATES ON FATE AND TRANSPORT OF THE OIL

Paul Boehm, Exponent Environmental Sciences David Hollander, University of South Florida

Session Overview

Over the past five years much has been learned about the physical, chemical, biological and geologic processes controlling the selective partitioning, transport and fate (weathering, transformation, degradation and sedimentation) of petroleum (oil and gas) released from the Macondo well. These processes and their role in the evolution of oil in the environment have led to innovative observations and new hypotheses for interpreting the ultimate impacts of the spill. However, as a result of these new insights and transformative understanding of the behavior of released oil there is not total agreement on the ultimate fate of the oil both in terms of the diversity and complexity of processes involved and the spatial and temporal extent to which hydrocarbons are cycled through the environment.

This session began to integrate research results of individual PIs with evaluation of DWH's "Big Data" Natural Resource Damage Assessment (NRDA) assets to:

- Describe the fate and transport pathways of oil in various environmental "compartments"— from fresh oil to end state of weathering; from deep sea to marsh
- Provide a technically based narrative on what happened to the oil and its components over time (i.e., evolution)
- Compare methods used and interpretations of key data sets
- Identify gaps in our knowledge

Session Highlights

- Evaluations of fate and transport are fully informed only by use of the full "toolkit" of methods (molecular analyses; isotopic analyses; laboratory experiments; field experiments; field data; observational technologies)
 - Employment of multiple "tools" to address same questions
- Use of "Big Data" (<u>BP/NOAA-Response</u> and <u>NRDA</u> data sets) approaches in combination with research investigation-based data sets is the key approach to full understanding
 - Much is directly transferable to posing questions, focusing environmental monitoring, optimizing data uses, and integration of new technologies
 - Expanding uses of larger data sets (NOAA, BP)
- Reproducibility actually can happen (and for the most part did happen water and sediment data; fingerprinting methods)
 - Reproducibility of interpretations of same data sets was tested and found to be feasible and largely accomplished (but there are challenges)
- Full dialog on major Fate & Transport issues among academic, consulting, and industry researchers is highly beneficial (not to mention refreshing)
 - First substantive integration of Government and BP NRDA work into GOMRI research community
 - Data sets and findings among a varied set of researchers largely, but not completely, fit together well and explain the fate of the oil
 - Confidence that research community can address major issues of concern regarding oil spills

- Observations are best paired with rigorous analytical chemical fingerprinting, but the latter have limitations
 - Key starting points for defining initial exposures to oil and duration/persistence (potential for longterm harm or lack thereof)
 - Reaffirms resiliency and capacity of GOM to naturally respond to spills (microbial degradation, etc.)
- Weathering and biodegradation of oil greatly accelerated attenuation of harmful exposures
 - PAH biodegradation (half-lives) measured in GOM water for the first time

- Gaps and disconnects between findings from "traditional" geochemical methods and "research biogeochemical methods" (e.g., location and amount of oil on the sea bottom) – call this the "T-R Gap"
- Will require deeper dives (workshops?) into data and findings
- Close the oil chemistry gaps requiring investigation (e.g., other compounds from degradation and transformation)
- Closing the "T-R Gap"
- Carrying the fate and transport findings forward to address exposure and ecosystem health questions (the "so what" questions; e.g., residual oil in the marshes; oil remnants on the sea bottom)
- Inconsistencies in oil source identification approaches
- Plots with red and green (and brown) dots

EXTENDING THE USE OF INFORMATION FROM OIL SPILLS: SYNTHESIS AND APPLICATION OF RESEARCH AND OBSERVATIONS FROM REGIONS ALONG THE U.S. OUTER CONTINENTAL SHELF

LeighAnne Olsen, Gulf Research Program Maggie Walser, Gulf Research Program Rebecca Green, Bureau of Ocean Energy Management John Farrington, Woods Hole Oceanographic Institution** Duane Gill, Oklahoma State University **

**Invited Speaker

Session Overview

Research conducted in the aftermath of major offshore oil spills has contributed to a growing body of knowledge about the physical processes, ecosystem impacts, and socio-economic and health implications of oil spills. Significant scientific information has been collected from spills in U.S. and surrounding waters, including the Santa Barbara spill (1969), Ixtoc I (1979), Exxon Valdez (1989), Deepwater Horizon (DWH; 2010), and more recent incidents. To minimize future harms to ecosystems and human communities, a synthesis and transfer of this knowledge should inform environmental assessments and studies related to ongoing and projected offshore oil and gas activities, as well as preparedness and response to future spills.

This session encouraged an inclusive look at what we've learned and still need to know about the human and environmental impacts of oil spills. It sought to complement findings from DWH-related research (funded by GoMRI, NIEHS, NSF, others) by bringing in perspectives from other U.S. OCS regions where similar incidents have occurred or could occur. Presenters also explored what assets and tools can be put in place now to minimize harms to people and ecosystems during future spills (e.g., research opportunities; longitudinal observing assets; response assets; mitigation approaches).

Session Highlights

Context is Important:

- Synthesis of DWH knowledge should not be done in isolation of what is already known and what we need to know for future response. Research on oil spills can be found as early as the 1930s. The literature clusters around major spills, such as DWH and the Exxon Valdez, yet approximately 8,000 spills are reported each year in the United States. These represent opportunities to improve understanding of how to better prevent and mitigate harms.
- Baseline knowledge of ecosystems and human communities is critical for understanding oil spill impacts and the effectiveness of restoration and recovery efforts. It is important to remember that baselines are dynamic and need to inform causal analyses that take into account multiple stressors.

Human and Environmental Impacts are Interconnected:

- Issues related to baselines, vulnerability, risk, resilience, and recovery are important to understanding human and environmental systems, and to understanding impacts of oil spills on these often deeply interconnected systems.
- Research into the human dimensions of oil spills have revealed similar patterns of effects that extend beyond micro-level impacts at the individual level including suicide, alcohol and drug abuse, dysfunctional behavior, physical harms and psychological stress to middle range community impacts on family and group interactions and social capital, and to macro level effects on social structures and social dynamics; local economic and political structures; occupational structures, fiscal revenue streams, social services, social capital, demographic structures and community infrastructure.

- Fewer mechanisms exist for assessing and addressing impacts on human systems:
 - Regulatory drivers of oil spill response (e.g., Oil Pollution Act, Clean Water Act) have created an official response structure focused on environmental impacts with limited inclusion of human dimensions.
 - Communities affected by oil spills often have strong ties to environmental resources, but these
 impacts are not often captured in environmental or social sensitivity indices.
 - There is a large disparity between support for oil spill research and capacity development that
 is focused on the health/social sciences versus environmental sciences (e.g., 1% of the oil spill
 literature surveyed addressed human health or social impacts).
 - Net Environmental Benefit Analysis (NEBA) for spill response decision making is an integrative approach that seeks to incorporate both human and environmental impacts. Improved indices of recovery for both human communities and environmental resources are needed to inform NEBA analyses.

- Small and intermediate spills are ongoing and offer an opportunity for research that examines recovery timelines, cumulative impacts, and human dimensions.
- Syntheses of research within and across spills could help build a knowledge base that improves
 response and restoration capabilities for future spills. End user needs should be incorporated in such
 synthesis activities.
- Environmental Sensitivity Indices can be expanded to include more offshore resources and made dynamic to keep them up to date. Including social vulnerability mapping presents an opportunity for addressing the interconnections of human and environmental systems.
- A collaborative approach—that has crossed disciplines, sectors, and involved communities— has been critical to ongoing Exxon Valdez Oil Spill research and monitoring and presents a model for long term DWH work.
- In terms of the next oil spill: Are we better prepared to deploy necessary technologies for in situ oil spill measurements? Are we more ready to get into the field to look at human impacts?
- Funding needs to be made available for assessing human dimensions of oil spills (including
 physical and mental health impacts on individuals and social, cultural, and economic impacts on
 communities) and for developing strategies that reduce harms of oil spills and enhance the resilience
 of communities.

A TALE OF TWO (MEGA) SPILLS: COMPARISON OF DWH AND IXTOC-1 SCENARIOS, FATES AND EFFECTS

David Hollander, University of South Florida Adolfo Gracia, Universidad Nacional Autónoma de México John W. Tunnell Jr., Texas A&M University-Corpus Christi^{**} David Yoskowitz, Harte Research Institute^{**} **Invited Speaker

Session Overview

The goal of the session was to define commonality and delineate differences between the 1979 IXTOC-1 (sGoM) and 2010 DWH (nGoM) sub-marine, oil-well blowout events. The IXTOC-1 event occurred 80 kilometers offshore at 56-meters depth and released >140 million gallons of oil over a 9.7-month interval while the DWH event occurred 80 kilometers offshore at 1500-meters depth and released >200 million gallons of oil over a 3-month interval. Although the depths and duration of these two events were quite different, both were characterized by the widespread coverage of surface oil and the deposition of sedimentary oil impacting waters, coastlines, sediments and biological systems with tremendous consequences on marine ecosystems, coastal human communities and regional economies.

This session provided a comparative perspective of the IXTOC-1 and DWH events. Presenters included scientists who conducted research during the 1979-1980 IXTOC-1 blowout event; are studying the evolution of environmental conditions and ecosystem impacts of the IXTOC-1 event through sedimentary analyses; and/or are focusing on current chemical and biological (from microbes to fish) conditions in the waters and surface sediments of the IXTOC- Southern GoM region. Topics presented provided a comprehensive and integrative view of the northern and southern Gulf environments and their ecosystems. The "Return to IXTOC" project provided a platform for interdisciplinary research among a broad range of scientists including ocean physicists, geologists, organic and metal geochemists, biological oceanographers, benthic ecologists, microbiologists, fishery scientists, ecosystem modelers and sociologists focused on ecosystems services and socio-economic impacts.

Session Highlights

- Understanding the ecologic impact and recovery-time of the benthic ecosystems are vital to evaluating the consequences of sub-marine blowouts on Gulf health and resilience.
 - Gulf-wide survey of fish and sediments provides a contaminant baseline comparison of the sGoM and nGoM.
 - Hydrocarbon concentrations in fish livers from the sGoM (long-term accumulation) are higher than the fish livers from the nGoM. In contrast, hydrocarbons in fish bile (short-term accumulation) indicate the opposite.
 - Sediments within the IXTOC industrial exclusion zone, the home to the majority of Mexican oil infrastructure, were not as contaminated as expected.
 - MOSSFA processes are recorded during both the IXTOC and DWH events and are likely associated with future sub-marine blowouts.
 - MOSSFA processes recorded in sediments from the IXTOC event are similar to those observed in the nGoM region from the DWH blowout.
 - Because MOSSFA events have long lasting impacts on the marine benthos, they can compromise the health sustainability and resilience of the Gulf.
 - MOSSFA events may be directly related to response strategies and therefore should be taken into consideration when response efforts are designed.

- Benthic faunal studies coupled with accurate sediment dating indicate that the recovery of the benthos from the IXTOC event took approximately 7-10 years compared to 3-5 years from the DWH event. Some benthic environments in the nGoM have not yet recovered.
 - Hydrocarbon contamination in sGoM mangrove habitats, lagoons and leeward side of reefs (low energy environments) still persistent for over 3 decades after the IXTOC blowout event.
- Sociological and socio-economic impacts and consequence to coastal communities resulting from a mega oil spill need to be evaluated relative to various cultural norms and local traditions.

- Studies of shallow water coastal system- lagoons, mangrove habitats, leeward reefs
- Studies on the impacts to coastal communities
- Capturing the broad array of historical data
 - Collected but not published by academics, government and industry
- Acquiring sediment and biological samples (from benthos, water column and fish) collected before, during and after the 1979 IXTOC-1 blowout

ECOLOGY, ECOSYSTEM SERVICES AND RELATED METHODOLOGIES

Sessions

- Sustainable Coasts and Human Impacts on Marsh Food Webs in the Gulf of Mexico
- Ecological Impacts of the Deepwater Horizon Oil Spill Impacts across Multiple Scales
- Gulf of Mexico's Large Marine Vertebrates as Indicators of Ecosystem Recovery, Resilience and Restoration Success
- The Physiological Resiliency of Marine Fish and Invertebrates following Oil Exposure
- Animal Oil/Dispersant Exposure Trials Post-Deepwater Horizon: Design, Analysis and Interpretation of Results
- Incorporating an Ecosystem Services Approach into Restoration and Coastal Management

Overarching Highlights

- The context of GOM restoration is embedded within the influences of the Mississippi River and local watersheds, global climate change, and sea level rise.
 - Everything in the marsh is a little oily, but it's not all Macondo oil (or even petroleum).
 - Food web impacts of oil are mediated both by oil sensitivity and food web role of different taxa.
 - Important and/or sensitive organisms (e.g., oysters, forage fish, corals) have large ecosystem impacts with bottom-up effects.
 - The resiliency of deepsea communities is impacted by their life history, sensitivity to disturbance and slow metabolism.
 - Some aspects of response itself (e.g., use of dispersants, physical disturbance, fisheries closures) impacted ecosystems.
- Long-term, consistent data sets are needed to monitor recovery and establish post-spill baseline values.
 - Baseline (pre-spill) data on large marine vertebrate (LMV) abundance, habitat use, and vital rates were lacking for nearly all LMVs. Measurable effects of DWH oil spill were reported at both individual and population levels across LMV categories.
 - Baselines for deepsea communities are also lacking.
 - Determining the toxicity/potential impacts of oil is not as simple as putting oil and a fish in beaker.
 - Molecular-level responses need to be connected to effects observed at more complex levels of biological organization.
 - Exposure to oil must be considered in the context of other environmental stressors (temperature, hypoxia, salinity, etc.).
 - o This requires a better understanding of natural and anthropogenic stressors as related to restoration.
- Impacted ecosystem services could be a focus of restoration.
 - An ecosystem services perspective allows us to think about what we can gain and helps us to understand the impact of investment in restoration.
 - Federal mandates from the highest levels are coming online to incorporate an ecosystem services approach into federal decision-making and the science surrounding ecosystem services has matured. There are well-understood and well-vetted frameworks available to use.
 - Restoration is moving toward systems-level thinking.
 - Spatially-explicit habitat modeling and a structured decision-making approach can help guide restoration and monitoring efforts – but the models need data!

- Maintaining critical ecosystem services in the face of future oil spills requires broadening the focus
 from economically valuable species to include both the food webs that support them and the fishing
 communities that harvest them.
 - Ecological studies need more social-economic monitoring, and combined streams of biophysical and social data.
 - Managers need better science on more robust modeling of ecosystem services provisions and more explicit functional connections.
- It is challenging to make management decisions in the absence of basic baseline data.
 - Resource managers especially need baselines of sensitive and/or understudied communities.
 - Summarizing and memorializing the volume of studies to inform future researchers and responders is a priority.
- Continued acquisition of long time series and baseline data will require funding opportunities.
 - NRDA funding stops when the case is settled.
 - Maintaining collaborative interdisciplinary research under future funding scenarios where funding comes from multiple sources.
- Lack of understanding of the fundamental biology of many Gulf species makes determining oil impacts difficult.
 - There is a lack of understanding in how responses to oil at the molecular/physiological level translate to ecologically-meaningful outcomes.
 - There is a lack of understanding the complexities of scaling up from individual level effects to population and ecosystem or societal level effects.
 - Interpreting exposure trials requires moving from reductionism to holism.
- Better communication is needed to link new research and findings to policy and management decisions.
 - The focus should transition from quantifying impacts and collecting basic information to designing appropriate restoration activities.
 - Modeling of freshwater diversions and food web structure can help guide responses to future spills.
 - Major advances in understanding, experimental protocols and interpretation of exposure effects (by generalizing/modeling toxicokinetics and exposure outcomes) will inform future spill outcomes and response.

SUSTAINABLE COASTS AND HUMAN IMPACTS ON MARSH FOOD WEBS IN THE GULF OF MEXICO

R. Eugene Turner, Louisiana State University Olaf Jensen, Rutgers University Nancy Rabalais, Louisiana Universities Marine Consortium Michael Polito, Louisiana State University

Session Overview

This session discussed perspectives for a sustainable Gulf of Mexico coast, with oil as only one of many stressors of different temporal and spatial impacts. The first part of this session discussed the present conditions of eutrophication, uneven management engagement, and sliding backwards in context of the future threats of climate change, sea level rise, population and more intense resource exploitation. Successful examples of adaptive agricultural practices in the watershed are shown to greatly improve both farming and water quality; implementation broadly is the obstacle. The second part focused on how changes to the oiled and unoiled GOM coastal marshes affect food webs. How resilient or vulnerable are marsh food webs to oil and associated impacts? What measures of food web stability and structure are the most responsive to anthropogenic stressors? Are there critical "keystone species" whose response triggers significant changes in the rest of the food web? Or is there trophic redundancy in which multiple species fill overlapping roles? Can we respond to oil spills in ways that increase resilience of marsh food webs? How do changes in food webs alter the ecosystem services provided by salt marshes?

Session Highlights

- The context of GOM restoration is embedded within the influences of the Mississippi River and local watersheds, global climate change, and sea level rise.
- There are many examples of surprisingly resilient species & communities #OceanOptimism.
- Everything in the marsh is a little oily, but it's not all Macondo oil (or even petroleum).
- Food web impacts of oil are mediated both by oil sensitivity and food web role of different taxa.

- Efforts to protect Gulf coastal ecosystems must expand their focus well beyond the coast.
- Maintaining critical ecosystem services in the face of future oil spills requires broadening the focus from economically valuable species to include both the food webs that support them and the fishing communities that harvest them.
- Modeling of freshwater diversions and food web structure can help guide responses to future spills.

ECOLOGICAL IMPACTS OF THE DEEPWATER HORIZON OIL SPILL IMPACTS ACROSS MULTIPLE SCALES

David Portnoy, Texas A&M - Corpus Christi Will Patterson, University of South Alabama Jeff Chanton, Florida State University** Dean Grubbs, FSU Coastal and Marine Lab** **Invited Speaker

Session Overview

Five years after the sinking of the Deepwater Horizon drilling rig, a much greater understanding exists as to the spatial and temporal scales over which spill impacts have occurred, some of which continue to persist and may sometime into the future. Evidence also has emerged with respect to the resiliency displayed by certain components of the Gulf ecosystem. This session summarized and discussed acute and chronic effects of the spill from organismal to ecosystem levels, and described the nature of Gulf ecosystem recovery where evidence of recovery exists. Presentations looked across a variety of scales and ecosystems, from single celled organism to large vertebrates, and across the Estuarine-Shelf-Deepwater spectrum. Of particular interest was whether observed recovery indicates resilience (return to pre-oil spill state) or movement to a new stable state.

Session Highlights

- Use of isotopes to trace fate and impact of oil and gas on GOM food webs
- Contextualize results with respect to confounding factors (fisheries closures, environmental factors, invasive species)
- Time series/continued scientific monitoring
- Deepsea community challenges: lack of baselines, sensitivity, slow metabolism, resiliency impacted by life history
- Identified important and/or sensitive organisms that have large ecosystem impacts e.g., oysters, forage fish, corals, bottom-up effects
- Identified aspects of response itself that impacted ecosystems e.g., use of dispersants, physical disturbance, fisheries closures
- Impacts to human well-being: impacted ecosystem services could be a focus of restoration

- Baselines of sensitive/understudied communities
 - Continued acquisition of long time series and baseline data is needed and that will require funding opportunities
- Maintaining collaborative interdisciplinary research under future funding scenarios
 - Important to note that this funding could come from multiple sources not just GOMRI
- Shifting baselines
- Understanding the complexities of going from individual level effects to population and ecosystem level effects

GULF OF MEXICO'S LARGE MARINE VERTEBRATES AS INDICATORS OF ECOSYSTEM RECOVERY, RESILIENCE AND RESTORATION SUCCESS

Pamela Plotkin, Texas A&M University Vicki Cornish, Marine Mammal Commission Jeffrey Gleason, U.S. Fish & Wildlife Service

Session Overview

Large marine vertebrates (LMV: birds, sea turtles, marine mammals, and pelagic fish) are important indicators of ecosystem health due to their long-life, ecological diversity, and ability to integrate changes in the environment over space and time. Understanding how, where, and why they use habitat is important (and largely missing) as an indicator of ecosystem health or the presence of oil.

The primary goal for this session was to focus on identifying and mitigating the impacts of natural and anthropogenic stressors to large marine vertebrates and identify areas for interdisciplinary collaboration. Bringing research communities together allowed us to learn from one another (e.g., the bird monitoring community of practice had many lessons to offer) as we strive to understand impacts and ecosystem linkages. Approximately 100 people attended the LMV session, representing a broad range of disciplines. The information and ideas presented at the session should help foster collaboration across the LMV research communities. One example of an emerging LMV collaboration discussed at the conference is the Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS), a Gulf-wide comprehensive monitoring effort led by the Bureau of Ocean Energy & Management (BOEM) in partnership with the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, and the Navy.

Session Highlights

- Systematic analysis of monitoring efforts revealed broad gaps in LMV categories through space and time.
- Baseline (pre-spill) data on LMV abundance, habitat use, and vital rates were lacking for nearly all LMVs. Measurable effects of DWH oil spill were reported at both individual and population levels across LMV categories.
 - Red snapper genes may be under selection from oil exposure
 - Kemp's ridley sea turtle nesting intervals are increasing post-spill, with implications for potential slowing of future population growth
 - Sperm whale diving behavior shows avoidance of spill site, may be indicative of how and where benthic communities were impacted by oil
- Spatially-explicit habitat modeling and a structured decision-making approach can help guide restoration and monitoring efforts but the models need data!
 - Out of 30,000 Gulf islands, modeling tells us only 450 are suitable for pelican nesting
- Long-term, consistent data sets are needed to monitor recovery and establish post-spill baseline values.
 - Data collection should be Gulf-wide and include nearshore and offshore habitats
 - Need to compile and synthesize existing/historical data sets

- Need better baseline information on vital rates and how these might be changing (example: increasing Kemps ridley sea turtle nesting intervals).
- Offshore monitoring is a persistent gap across species, but coastal populations have important needs as well (considering the high degree of endemism in species such as marsh birds and bottlenose dolphins).
- It is challenging to make management decisions in the absence of basic baseline data for many LMVs.
- Better communication is needed to link new research and findings to policy and management decisions.
- Need to transition from quantifying impacts and collecting basic information to designing appropriate restoration activities.

THE PHYSIOLOGICAL RESILIENCY OF MARINE FISH AND INVERTEBRATES FOLLOWING OIL EXPOSURE

Aaron Roberts, University of North Texas Dane Crossley, University of North Texas Martin Grosell, University of Miami** **Invited Speaker

Session Overview

Recovery is a key metric that needs to be assessed when investigating the long-term ecological impact of an oil spill event. The physiological responses and adaptations of species that inhabit an ecosystem are the primary drivers that facilitate recovery. Fish and invertebrate species comprise a crucial component of the Gulf of Mexico (GoM) ecosystem as commercially, recreationally, and ecologically important species. Recent publications have highlighted the sensitivity of these species to oil-derived polycyclic aromatic hydrocarbon (PAH) toxicity. In particular, effects on swim performance, development, and sensitivity to UV-radiation have been highlighted.

The focus of the session was to examine mechanisms behind previously established outcomes in organisms exposed to oil. Elucidating these mechanisms provides a more complete understanding of potential GoM ecosystem impacts. Presentations included discussions of cardiotoxicity in fish, "omic" responses in fish and invertebrates, and the role of non-chemical factors in toxicity.

Session Highlights

- Determining the toxicity/potential impacts of oil is not as simple as putting oil and a fish in beaker.
- Most of the presentations were authored by physiologists/toxicologists/ecologists/molecular biologists from multiple institutions demonstrating the power of interdisciplinary teams.
- We still have a tremendous amount to learn about the sublethal/mechanistic aspects of oil toxicity.
- We are just scratching the surface in understanding the mechanisms by which oil may exert sublethal effects.
- This is highlighted by a need to connect molecular-level responses to effects observed at more complex levels of biological organization.

- Lack of understanding of the fundamental biology of many GoM species makes determining oil impacts difficult.
- Lack of oil preparation/measurement methods across laboratories (e.g., standard protocols) makes data comparison difficult.
- There is a lack of understanding in how responses to oil at the molecular/physiological level translate to ecologically-meaningful outcomes.

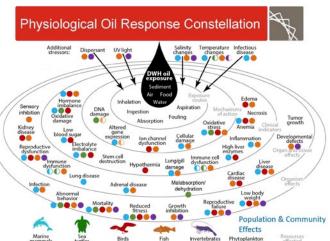
ANIMAL OIL/DISPERSANT EXPOSURE TRIALS POST-DEEPWATER HORIZON: DESIGN, ANALYSIS AND INTERPRETATION OF RESULTS

Steven Murawski, University of South Florida Dana Wetzel, Mote Marine Laboratory Robert (Joe) Griffitt, University of Southern Mississippi**

Session Overview

In vitro experiments are a commonly used methodology to understand and interpret dose-response effects and for identifying health outcomes for species contaminated with petrochemicals (e.g., oil and dispersants). Such experiments offer the opportunity to isolate particular oil components and exposure routes free from the confounding effects in nature such as chronic exposure to target and non-target chemicals, as with field-caught specimens. Numerous animal exposure trials have been completed in the wake of Deepwater Horizon, and new, large-scale trials are ongoing.

A primary goal of the session was to review results to date, identify logical gaps in exposure studies conducted to date and suggest highpriority experiments going forward. Additional goals included determining which parameters



Citation: Deepwater Horizon Natural Resource Damage Assessment Trustees. (2016). Deepwater Horizon oil spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement. Retrieved from http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan

are important for informing toxicokinetic models, and developing a series of "best practices" when designing exposure trials involving oil and dispersant effects.

This session brought together information from dozens (100s?) of studies sponsored by NRDA¹, the Gulf of Mexico Research Initiative, and other government and private funders. Presentations reflected a diversity of studies across taxonomic groups and scientific disciplines, and demonstrated the emergence of advanced genomics approaches to identify up/down gene expression.

Session Highlights

- Exposure to oil does not always result in acute mortality; oil can affect animals in less obvious but equally disruptive ways
- Design experiments that use appropriate/realistic exposure scenarios and use innovative experimental designs and technologies to evaluate impacts
 - Exposure in the context of other environmental stressors (temperature, hypoxia, salinity, etc.)
 - Better understanding of natural and anthropogenic stressors as related to restoration
- Understanding organism-oriented studies with respect to population and community level impacts
 - Objectives are to better assess long term effects and mitigation of the impacts of future spills

- Summarizing and memorializing the volume of studies to inform future researchers and responders (e.g., NRDA funding stops when the case is settled)
- Moving from reductionism to holism (interpreting exposure trials in the real-world)
 - Generalizing/modeling toxicokinetics and exposure outcomes for future spill scenarios
 - Major advances in understanding, experimental protocols and interpretation of exposure effects informing future spill response

INCORPORATING AN ECOSYSTEM SERVICES APPROACH INTO RESTORATION AND COASTAL MANAGEMENT

Heather Mannix, COMPASS

David Yoskowitz, Harte Research Institute Erica Goldman, COMPASS

Session Overview

In the five years since the Deepwater Horizon disaster, we have witnessed a significant investment in research to understand the effect of oil spills on ecosystems and communities. As the focus now shifts from shorter-term response to longer-term restoration efforts, incorporating an ecosystem services approach, one that explicitly accounts for the benefits of nature in decisions, could enhance ecological and economic recovery and has the potential to transform how society approaches and evaluates restoration at both large and small scales.

An ecosystem services approach can provide a systems-level framework to link biophysical sciences and social sciences for better understanding and management of restoration goals and outcomes. This session brought together scientists and policy makers. A panel discussion with perspectives from the White House Council on Environmental Quality, RESTORE Council Staff, Natural Resources Damage Assessment (NRDA) program, and a state level perspective from the Louisiana Coastal Planning and Restoration Authority gave us the context to understand how the U.S. is incorporating an ecosystem services perspective into federal and state decisions. Following the policy panel, scientists and practitioners presented case studies on a variety of ecosystem services approaches and methods from around the Gulf of Mexico; specifically:

- A method of analyzing the cost efficiency of restoration projects
- Private investment in restoration that could provide viable alternatives to public funding
- A case study on willingness-to-pay approaches for recreational activities in Sarasota Bay
- New methods for quantifying storm protection benefits
- Business/industry-led efforts to incorporate ES approaches in the Houston area

Session Highlights

- The session looked at the role of ecosystem services approach in the Gulf to date and discussed how this approach helps us to understand the impact of investment in restoration.
- There is opportunity now to incorporate an ecosystem services framework into the Gulf from both a scientific and policy perspective. Federal mandates are coming online to incorporate an ecosystem services approach into federal decision-making and the science surrounding ecosystem services has matured. There are well-understood and well-vetted frameworks available to use.
- Using an ecosystem services framework changes how restoration goals are set, where restoration is done, how restoration is done and how success is measured. These frameworks help us to approach restoration on the front end through project selection and siting and on the back end through project monitoring and evaluation.
- Restoration has traditionally focused on quantifying what we have lost by using historical baselines. An ecosystem services perspective allows us to think about what we can gain.

- Restoration has typically focused on small scale, single objectives; we are now moving towards systems-level thinking, medium/large scale, and multiple objectives. An ecosystem services approach helps to fully understand the benefits and trade-offs.
- We need better science on more robust modeling of ecosystem services provisions and more explicit functional connections.
- We need more social-economic monitoring, and combined streams of biophysical and social data. We can implement an ecosystem services approach now from a biophysical perspective, but we lack the information on social perspectives, a necessary ingredient in determining restoration planning and outcomes. Future funds from the BP settlement that are set aside for monitoring provide an opportunity to think about incorporating these aspects.

PUBLIC HEALTH AND SOCIOECONOMICS

Sessions

- One Health: Unraveling the Interconnectedness between Human and Ecosystem Health through the Lens of Oil Spills
- Human Functioning and Adaptation to Stress: Implications of Prolonged Exposure for Individuals and Communities

Overarching Highlights

- Cumulative disaster exposure may be associated with lifetime adversity.
 - Longitudinal cohort studies are the gold standard research design to assess cumulative environmental health risks.
 - Retrospective epidemiologic studies are the backbone of prospective, predictive research.
- Environmental health literacy increases sustainable interventions and preventive actions.
- Resilience—despite its many definitions—was presented as a common term on which to build among the varying sciences.
 - Language of resilience (bounce back) is a common language and interest among disciplines.
- Ultimately creating a network of response systems that can address common questions related to the interconnectedness of disaster behavioral, environmental, and social health principals and overall disaster response capacity.
 - Repository of tools has the potential to accelerate disaster response research.
 - Collaborative efforts can expand applicability of research to general population and policy.

- Models exist but the research lacking to examine the mechanisms by which nature and biodiversity enhance ecosystem services and support psychological, physiological and community health.
- As scientists we need to improve communication of findings that are understandable to the general public, inform social justice, and improve health disparities.
 - Bridging the science to society gap engages stakeholders and communities with science which allows for clear messages, open lines of communication, and connection with programmatic development.
 - Progress has been made to develop more effective methods to advance environmental health literacy, such as Community-Based Participatory Research (CBPR) but more is needed.
 - In order for communities to be resilient, both the issues of ecosystem and population health need to be addressed in a collaborative fashion.
 - Assessments of baseline health status of different communities have seen little progress.
 - More opportunities to synthesize research from social, ecological and biological disciplines are needed.
 - Improving data synthesis across fields of science to facilitate research to community action is critical.

ONE HEALTH: UNRAVELING THE INTERCONNECTEDNESS BETWEEN HUMAN AND ECOSYSTEM HEALTH THROUGH THE LENS OF OIL SPILLS

Maureen Lichtveld, Tulane University, School of Public Health and Tropical Medicine Blanca Laffon, University of A Coruña Elaine Faustman, University of Washington Mina Ha, Dankook University College of Medicine Linda Birnbaum, National Institutes of Health** Bernard Goldstein, University of Pittsburgh** LeighAnne Olsen, Gulf Research Program** **Invited Speaker

Session Overview

Human and ecosystem health are impacted by the environment in its broadest sense: from physicochemical processes to the built, psychosocial and policy realms. Oil spills and other releases of hazardous substances into the environment have traditionally been examined in a silo fashion as a strict physicochemical event. Moreover, minimal progress has been made to support transdisciplinary research examining the reciprocal impact of oil spills on human and ecosystem health as one interconnected system.

This session examined the interconnectedness between human and ecosystem health through the lens of oil spills from three science-driven perspectives: the biology to health outcome approach— "from bench to trench;" cumulative risk associated with the interaction of chemical and non-chemical stressors; and the pathophysiology to repair continuum. In addition to the central focus on Gulf coast communities and its ecosystem, to broaden our knowledge base, presentations featured recent international oil spill research findings. A moderated capstone panel representing international and domestic investigators and funding organizations discussed key research priorities.

Session Highlights

- · Gene-environment interactions in humans and ecosystems cross boundaries
- Cumulative disaster exposure may be associated with lifetime adversity
 - Longitudinal cohort studies are the gold standard research design to assess cumulative environmental health risks
 - Retrospective epidemiologic studies are the backbone of prospective, predictive research
 - Participant cohorts of women, infants, and workers and related biospecimen repositories (blood, urine, saliva, placenta, umbilical cord blood, hair, nails, teeth, breast milk) of ongoing human health studies provide unique opportunities for future one health research
- · A global approach to human health research provides distinct advantages
 - Environmental health literacy increases sustainable interventions and preventive actions
 - Repository of tools has the potential to accelerate disaster response research

- 2014-2015 Priority research gaps Progress
 - Invest in Cross-Disciplinary Partnerships- still lacking
 - Assess baseline health status of different communities- inter-disaster as surrogate: gap
 - Strengthen the science of resilience- promising but limited progress made
 - Comprehensively characterize background levels of exposure in communities to better examine changes in health over time-inter-disaster as surrogate: gap
 - Develop more effective methods to advance environmental health literacy-progress being made (GRHOP); NAS Gulf research program provides opportunity
 - Promote the use of locally-collected data to inform the risk assessment decision making process-Successful recent study in Vietnamese in La; many more needed
 - Prioritize health studies in at-risk communities inter/trans generational research: gap
 - Examine the mechanisms by which nature and biodiversity enhance ecosystem services and support psychological, physiological, and community health- models exist; research lacking; discussed in other sessions
- 2016 "Cumulative" Priority research gaps
 - Analyze health consequences in susceptible populations
 - Embed cumulative risk assessments (EJ) in longitudinal cohort studies
 - Improve air quality (indoor and outdoor) monitoring to characterize inhalation exposure
 - Conduct culturally-tailored dietary assessments targeting risks and benefits of seafood consumption
 - Leverage existing women/child dyads and worker cohorts to advance transdisciplinary research at the human /environment interface
 - "Mine" biospecimen repositories to expand biomarker portfolio- finger printing exposure, effect but especially susceptibility
 - Advance CBPR by strengthening environmental health literacy
 - Improve data synthesis across fields of science to facilitate research to community action

HUMAN FUNCTIONING AND ADAPTATION TO STRESS: IMPLICATIONS OF PROLONGED EXPOSURE FOR INDIVIDUALS AND COMMUNITIES

Howard Osofsky, MD, Louisiana State University Health Sciences Center Ann Hayward Walker, SEA Consulting Group Lisanne Brown, Louisiana Public Health Institute Melissa Brymer, National Center for Child Traumatic Stress** Paul Sandifer, College of Charleston** **Invited Speaker

Session Overview

The consequences of the 2010 DWH oil spill on the psychological and physical health of humans was immediate, continues to the present time, and will impact the quality of life of communities and people for the foreseeable future. Human functioning and adaptation to adverse events is often misunderstood and misinterpreted by policy makers, public officials, supervisors, and most unfortunately, individuals who are directly affected. At the 2016 Gulf of Mexico Research Initiative annual conference, scientists and practitioners from a myriad of disciplines gathered together to present a two part session entitled Human Functioning and Adaptation to Stress: Implications of Prolonged Exposure for Individuals and Communities. The sessions were comprised of 23 presentations; 10 single presentations and 13 divided among 4 panels—Children and Families, Impact and Resilience, Collaborative Models, and Integrated Health Response. The sessions highlighted what many researchers have noted for some time that the oil spill has provided an opportunity to advance collaborative multidisciplinary research and examined the impact of acute and prolonged exposure to stressors on multiple aspects of response and recovery.

The conference theme "One Gulf" underscores the importance of ecology and the interaction of humans with their environment. Understanding human behavior following disaster requires a multidisciplinary effort and only through collaborative research designs will we advance our understanding of social, biological and ecological resilience following disaster.

Session Highlights

A general theme that emerged from the conference was the emphasis on resilience and the individual and community's ability to bounce back. It was stressed that through research we need to find ways to build resilience and support environmental health that lead to improved psychological and physical well-being. Examples of multidisciplinary research include biological and genetic markers that influence behavioral health and geological surveillance, mental health, and decisions to evacuate in disasters. Integrated research will allow understanding of how to best build community, environmental, and individual resilience.

- Importance of multidisciplinary research to advance disaster recovery knowledge
 - Research on human functioning following oil spills is ongoing and findings are slowly becoming available. More opportunities to synthesize research from social, ecological and biological disciplines are needed.
- Supportive factors such as social capital and resilience should be emphasized
 - A surprising finding was that the language of resilience (bounce back) is a common language and interest among disciplines.
 - Behavioral health should address both real and perceived concerns. Knowledge of demographic factors can help target response.
 - Unanticipated commonalities across disciplines included the language of resilience—despite its many definitions—was presented as a common term on which to build among the varying sciences.
 - Researchers emphasized the strengths of Gulf Coast residents and what scientific findings mean for local communities.

- Collaborative efforts can expand applicability of research to general population and policy.
 - Characteristics of disasters are an important consideration—cannot generalize for all disasters, but we can develop methods for coordinated response models and processes.

- As scientists we need to improve communication of findings that are understandable to the general public, inform social justice, and improve health disparities.
- Challenges identified include: lack of pre-existing data; multidisciplinary research often takes longer and scientific languages are different; and translating academic results for public consumers.
- In order for communities to be resilient, both the issues of ecosystem and population health need to be addressed in a collaborative fashion.

The conference provided a platform to discuss current multidisciplinary research, encourage collaboration for future endeavors, and promote outreach to non-traditional partners, such as community members, policy makers, and other stakeholders. Bridging the science to society gap engages stakeholders and communities with science which allows for clear messages, open lines of communication, and connection with programmatic development. In essence, we are creating a network of response systems that can address common questions related to the interconnectedness of disaster behavioral, environmental, and social health principals and overall disaster response capacity.

While the conversations are just beginning regarding the importance of including behavioral health into the multidisciplinary understanding on the effects of the current oil spill, the dialogue holds great potential to inform future disasters and preparedness.

DATA MANAGEMENT, MODELING AND DECISION-MAKING

Sessions

- Data Portals, Integrated Datasets, and Tools Supporting Researchers Synthesizing Gulf of Mexico Oil Spill and Ecosystem Science
- Applications of Research in Oil Spill Transport, Fate and Effects Modeling for Decision Support and Ecosystem Services
- Fusion of Bio-physical Data and Predictive Modeling to Understand Gulf of Mexico Marine Species Resilience to Environmental Stresses and Disasters

Overarching Highlights

- Open data requirements are increasingly accepted by scientists and expected by funders, journals, peers, and the public.
 - Open data access adds to transparency, verification, validation and reproducibility.
- Special-purpose databases and applications (e.g., corals, satellite products, marine planning tools) are increasing in sophistication but long-term availability of data is an issue.
 - Environmental baseline and current project data informs restoration programs.
 - Advancements in integrated modeling and Common Operational Picture (COP) informs future oil spill response efforts.
- Information needs to be integrated from remote sensing of surface oil to humans walking along a beach. No one method stands alone with enough information.
- Human health, happiness and well-being requires timely, realistic, and understandable information as well as efficient closure to the event in order to heal.

- Machine access to datasets and linking across repositories is a requirement for information management in the 21st century. Adoption by the science community lags.
- There are varying levels of standards adoption and practice.
 - Research must bridge laboratory, mesoscale and field work into the precision and statistics of modeling.
 - The community needs to bridge gaps in attitude, funding methods and mental models in order to join research, government and industry expertise together to form a scientifically sound interdisciplinary and useful knowledge base before, during and after a spill.
- Ensuring long-term monitoring and special application databases and tools remain available across
 programs and decades without loss is a challenge.
- Need for innovative data collection strategies for oceanographic data and called for field experiments to properly describe the Mississippi river input into the Gulf.

DATA PORTALS, INTEGRATED DATASETS, AND TOOLS SUPPORTING RESEARCHERS SYNTHESIZING GULF OF MEXICO OIL SPILL AND ECOSYSTEM SCIENCE

James Gibeaut, Texas A&M University - Corpus Christi Matthew Howard, Texas A&M University - College Station Cynthia Chandler, Woods Hole Oceanographic Institution** **Invited Speaker

Session Overview

Data management and informatics support syntheses by making data and information easier to find, use and understand. Presentation topics included research databases, data publishing, data discovery, access and integration, and provided case studies for integrative research products. Talks illustrated how informatics are used to support the end-to-end transformation of data to products and information.

Session Highlights

- Open data requirements are increasingly accepted by scientists and expected by funders, journals, peers, and the public.
 - Open data access adds to transparency, verification, validation and reproducibility.
 - There is increased interest on making data publicly available sooner.
- The ability to link across sources to discover a dataset, related data, publications, and people is key.
- Special-purpose databases and applications (e.g., corals, satellite products, marine planning tools) are increasing in sophistication but long-term availability of data is an issue.
 - Environmental baseline and current project data informs restoration programs.
 - Predictive modeling informed with data readily available on resources at risk can support future oil spill response efforts.

- Standards and data models are needed to carry data from acquisition to integration and analysis without loss of information adoption and attention to detail is the challenge.
- Machine access to datasets and linking across repositories is a requirement for information management in the 21st century. Adoption by the science community lags.
- Curating data from multiple sources acquired through multiple funding sources for multiple purposes is challenging due to varying levels of standards adoption and practice.
- Integrating structured and unstructured data and heterogeneous data is difficult.
- Ensuring long-term monitoring and special application databases and tools remain available across programs and decades without loss is a challenge.
- Data explosions challenge hardware and human resources.

APPLICATIONS OF RESEARCH IN OIL SPILL TRANSPORT, FATE AND EFFECTS MODELING FOR DECISION SUPPORT AND ECOSYSTEM SERVICES

CJ Beegle-Krause, SINTEF MK Environmental Technology Christopher Barker, NOAA Louis Thibodeaux, Louisiana State University

Session Overview

Oil spill models are integrated computer systems that simulate the transport, fate, and effects of oil spills. Such models are critical to Decision Makers before, during, and after an oil spill. Before an oil spill, these models provide risk assessment and planning opportunities, during a spill these models provide guidance to the response, including evaluating tradeoffs between different response options, and after a spill these models are used to assess injury. The session covered specific types of modeling, different processes modeled, data input for models, and key natural resources areas.

Modeling in support of oil spills is used by government, industry, and nonprofits for a multitude of purposes, such as planning (from risk of a spill to risk to environmental resources); response (mitigating environmental harm from the spill and the response efforts through NRDA); and assessment & restoration (from aquatic species to sensitive marshes).

These models involve putting together winds, currents, infrastructure, and oil chemistry as well as natural resources: birds, fish, wildlife, and human use. Decision makers need scientific information in order to understand the tradeoffs among response measures, or, at times, not responding when response measures cause more harm than good. For example, application of dispersants, surface and subsurface, alters whether the oil is at the surface where birds can be harmed vs. in the water column where larval fish may be harmed. Similarly, wetlands are very sensitive to oil, so people walking on the oil may drive it into the sediments, delaying recovery, while burning the oiled marsh grass will remove the oil quickly and allow the marsh to regrow.

Session Highlights

- Information integrating oil infrastructure, oceanography, oil chemistry, chemical engineering, biology, toxicology and consequences is needed – the DWH set a new bar and has resulted in new science being brought into Decision Support.
- Information needs to be integrated from remote sensing of surface oil to humans walking along a beach. All response actions (including no response) have effects on the environment, so plans must be developed considering potential environmental and Human, Health and Safety benefits through Net Environmental Benefit (NEBA) analysis.
- Bringing together information from a wide range of disciplines improves development of a unified description that informs response and restoration (from reservoir to beach and marsh).
- Advancements in integrated modeling and Common Operational Picture (COP) inform future oil spill response efforts.
- Human health, happiness, and well-being require timely, realistic, and understandable information as well as efficient closure of the region in order to heal.
- Tiny oil droplets formation, dissolution, biodegradation (oil spills are more than oil slicks at the surface).
- "Good" vs "Better": No one wants an oil spill to occur, so term "good" is not used related to an oil spill. However, if we can leverage science, from laboratory to integrated predictive capability, then we can target response measures to make the outcome "better," and with understanding the actions of these response measures, guide the response to select wisely among response options.

- Chemical dispersants remain controversial
- Uncertainty estimates in scientific advice and modeling
- Bridging laboratory, mesoscale and field work into the precision and statistics of modeling
- Bridging gaps in attitude, funding methods and mental models in order to join research, government and industry expertise together to form a scientifically sound interdisciplinary and useful knowledge base before, during and after a spill.

FUSION OF BIO-PHYSICAL DATA AND PREDICTIVE MODELING TO UNDERSTAND GULF OF MEXICO MARINE SPECIES RESILIENCE TO ENVIRONMENTAL STRESSES AND DISASTERS

Natalia Sidorovskaia, University of Louisiana at Lafayette Azmy Ackleh, University of Louisiana at Lafayette Hal Caswell, University of Amsterdam** David Mellinger, Oregon State University**

**Invited Speaker

Session Overview

This session focused on cross-disciplinary methodologies and data assimilation that advance our understanding of how the regional marine species populations in the Northern Gulf of Mexico have been and will be affected by the 2010 oil spill and extensive everyday industrial operations. It emphasized integrating modeling and bio-physical observations to assess long-term impact of the spill and other disturbances on the Gulf ecosystem; as well as advancing knowledge of Northern Gulf oceanographic processes, taking into account Mississippi river flow, to inform biological sampling and eco-toxicology experiments. The first part of the session focused on predictive modeling approaches and population dynamics. Several novel cross-disciplinary modeling approaches were presented and applied to different species from endangered (sperm whales, amphibians) to invasive (Louisiana apple snails). These include sensitivity analysis, demographic stochasticity effects, parameter estimation, and model validation. The second part of the session addressed a wide-ranging collection of data (acoustics, oceanographic, biological) in the Gulf of Mexico for understanding functionality and inter-connectivity between different layers of the ecosystem.

Session Highlights

- A novel approach for sensitivity analysis to non-stationary dynamics after a disaster was introduced.
- Application to endangered sperm whales reveals that this population is most sensitive to adult survivorship.
- A method to derive probability of recovery to pre-event population level was presented and applied to sperm whales.
- The results show that endangered sperm whale population in the Gulf is very fragile and a reduction as little as 1% in adult survivorship due to an environmental event may lead to declining population.
- Habitat suitability models are presented and used to estimate juvenile pink shrimp population in the Tampa Bay.
- CONCORDE presented modeling and observation efforts to address how pulsed-river plumes control the exposure, impacts and ecosystem recovery.
- New methodologies for collecting passive acoustic data using autonomous platforms from the LADC-GEMM consortium summer experiment were highlighted.
- Presenters stressed the need for innovative data collection strategies for oceanographic data and called for field experiments to properly describe the Mississippi river input into the Gulf.
- Successes were demonstrated to advance the Gulf coastal circulation models to describe observed current fields near the Mississippi delta.

- Maintain long-term population and environment monitoring for developing accurate population forecasting models
- Develop algorithms for identifying individuals from visual and acoustic data to follow them through their life stage
- Improve estimates on vital rates including survivorship of individuals

ATTENDANCE AND DEMOGRAPHICS

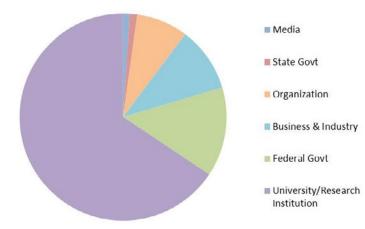
15 countries

Australia, Cameroon, Canada, France, Germany, India, Mexico, Netherlands, Norway, Nigeria, South Korea, Spain, Switzerland, Trinidad and Tobago, United Kingdom

37 states

Alabama, Alaska, Arizona, California, Colorado, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Nevada, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Virginia, Washington, Wisconsin, and Washington, DC.

Attendees by Sector



Attendee Survey Results

A 15-question survey was sent to conference attendees to gather their feedback on the conference. These survey responses inform the Executive Committee as they plan future conferences and guide its long-term evolution and purpose. Results from the 139 respondents indicate that, overall, the conference provides a valuable platform for networking among Gulf researchers and management professionals and information sharing via the oral and poster presentations. Attendees appreciated the introduction of NRDA data, and would like to see more application of oil spill science to management, restoration and spill response.

MEDIA

The conference submitted two national press releases through Business Wire (December 10, 2015, and January 20, 2016) to generate interest from national and local media. Ten members of news media registered, representing the Tampa Tribune, WGCU (local NPR affiliate), WTUL News and Views, HarperCollins, and the Florida Specifier. Searches through Business Wire and Google News returned 291 examples of coverage before, during, and after the meeting. The coverage includes stories in newspapers and magazines; on radio and television; and on various Internet sites, including blogs and press-release aggregators.

The conference also maintains a strong social media presence, with 192 Twitter followers and 190 Facebook followers. To date, at least 214 tweets have included one or both of the conference hashtags (#gulfscienceconference; #OneGulf).

The full media report is available in Appendix III (page 45).

APPENDIX I: CONFERENCE AGENDA

Overview Schedule for Monday, February 1, 2016

12:00p-6:00p	Registration & Check-in Open Exhibit Set Up
12:00p-7:00p	Speaker Ready Room Open
12:00p-4:00p	Poster Hang-Up
Associated Meetings and Events	

Associated meetings and Events	
12:30p-5:15p	Sharing Oil Spill Science with Non-Scientists: Effectively Communicating Complex Research Results through Outreach and Education Programs
1:00p-4:00p	Overview of the DWH NRDA Process
	Communicating Your Science
1:00p-5:00p	A Tribute to Louis J. Guillette, Jr.: "From Oil Spill to Sentinels and Human Health - Complexity in Modern Environmental Health Research"
	Lessons in Designing, Conducting and Interpreting Biodegradation and Toxicity Studies on Crude and Refined Oils
1:00p-6:00p	Status and Plans for Coastal & Ocean Observing Systems of the Gulf of Mexico Near Field Modeling Workshop
4:00p-6:00p	Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) – Informational Meeting
5:00p-6:00p	Overview and Status of Science Action Network
5:30p-7:30p	Student Welcome Reception

Overview Schedule for Tuesday, February 2, 2016

7:30a-6:00p	Registration & Check-in Open
8:00a-6:00p	Exhibits Open
0.00a-0.00p	Speaker Ready Room Open
8:00a-8:00p	Poster Hall Open
Opening Plenery Program Schedule	

Opening Plenary Program Schedule

-	
Starts at 7:30a	BREAKFAST
9:00a-10:00a	Welcome and Introduction Dr. Rita Colwell, Gulf of Mexico Research Initiative Research Board Keynote Address Dr. Marcia McNutt, American Association for the Advancement of Science (AAAS)
10:00a-10:30a	BREAK
10:30a-12:00p	Panel and Discussion
12:00p-1:30p	LUNCH

Scientific Program Schedule

1:30p-3:00p	Sessions 001 to 005
3:00p-3:30p	BREAK
3:30p -5:00p	Session 001 to 005
5:30p-7:30p	Poster Session & Reception (featuring Sessions 001 – 008, General Poster Session I, and Gulf Programs Special Session)

Associated Meetings and Events

10:00a-10:30a	Introduction to GRIIDC
12:00p-1:30p	Data Manager Luncheon State-of-Science for Dispersant Use in Arctic Waters
3:00p-3:30p	GRIIDC Data Submission

Overview Schedule for Wednesday, February 3, 2016

8:00a-8:00p	Poster Hall Open
7:30a-6:00p	Speaker Ready Room Open
8:00a-6:00p	Exhibits Open
7:30a-6:00p	Registration & Check-in Open
	8:00a-6:00p 7:30a-6:00p

-		
Starts at 7:00a	BREAKFAST	
8:30a-10:00a	Session 003 to 009	
10:00a-10:30a	BREAK	
10:30a-12:00p	Session 003 to 009	
12:00p-1:30p	LUNCH	
1:30p-3:00p	Session 009 to 016	
3:00p-3:30p	BREAK	
3:30p-5:00p	Session 009 to 016	
5:30p-7:30p	Poster Session & Reception (featuring Sessions 009 – 018 and General Poster Session II)	
Associated Mastings and Events		

Associated Meetings and Events

7:30a-8:30a	Environmental Disasters Data Management (EDDM)
10:00a-10:30a	GRIIDC Data Organization
3:00p-3:30p	Introduction to GRIIDC

Overview Schedule for Thursday, February 4, 2016

7:200 12:000	Registration & Check-in Open
7:30a-12:00p	Exhibits Open
7:00a-8:00a	Speaker Ready Room Open

Scientific Program Schedule

Starts at 7:00a	BREAKFAST
8:30a-10:00a	Session 012 to 018
10:00a-10:30a	BREAK
10:30a-12:00p	Session 012 to 018
12:00p-1:30p	LUNCH

Plenary Program Schedule

1:30p-3:30p	Session Summaries and Discussion Moderated by Dr. Chris Elfring, Gulf Research Program	
1.50p-5.50p	Conference Wrap-Up Dr. Chris Elfring	
Special Event		
3:30p-4:30p	Dispatches from the Gulf	

Associated Meetings and Events

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APPENDIX II: ASSOCIATED WORKSHOPS & MEETINGS

Sharing Oil Spill Science with Non-Scientists: Effectively Communicating Complex Research Results through Outreach and Education Programs

The four Sea Grant Programs in the Gulf of Mexico region, the Gulf of Mexico Research Initiative, and the Consortium for Ocean Leadership jointly co-hosted an outreach workshop which brought together outreach professionals in the oil spill science community. The goal was to provide them with information and resources on techniques for sharing science with non-science audiences, tools and technologies for sharing information including social media, documentaries, webinars, and short films, and assessment and evaluation techniques for evaluating outreach programs. Breakout sessions gave the audience members an opportunity to discuss outreach methods and challenges when addressing a variety of audiences, including the general public, the media, K-12, and the fishing community. The *workshop report* includes a summary of those breakout sessions, slides from the PowerPoint presentations, and additional resources provided by the workshop speakers and panelists.

Overview of the DWH NRDA Process

This session gave an overview of the Deepwater Horizon Natural Resource Damage Assessment (NRDA) process: what it is, what it means and what will happen now. Attendees were updated on the wealth of information that has been documented and the science surrounding the thousands of datasets. They also learned about the settlement, the terms, the payout and what it means for the Gulf in the future.

Message Box Training: Communicating Your Science

COMPASS delivered a workshop on Communicating your Science, which was designed to help scientists learn how to talk about their science and why it matters for wide variety of audiences. The interactive training helped scientists to identify the key messages arising from their research and understand the day-to-day pressures, constraints, and needs of different audiences (e.g., journalists, policymakers). As increasing amounts of scientific research are coming online in the Gulf of Mexico in the wake of the Deepwater Horizon Oil Spill, there is also increasing demand to connect this research to those who can use it. This workshop helped scientists be better prepared to share their science with those groups.

COMPASS is a not-for-profit, non-advocacy organization that has over a decade of experience helping scientists share their research with journalists, policymakers, and the wider world. COMPASS trainers are pioneers in the practice of science communication, with formal training in the sciences and professional experience in journalist, policy and other relevant fields.

A Tribute to Louis J. Guillette, Jr.: "From Oil Spill to Sentinels and Human Health -Complexity in Modern Environmental Health Research"

The GoMRI family paid tribute to an icon in the field, Dr. Louis Guillette, who passed away on August 6th, 2015. Environmental endocrine disrupting compounds (EDCs) were one of Lou's passions. EDCs have been implicated in most major health concerns, including obesity. In addition to diet and lifestyle, there is increasing evidence that environmental exposure to chemicals known as 'obesogens' may promote obesity. Human stem cell-based tools to identify and measure obesogens/EDCs are an avenue of investigation, as are clinical investigations and sentinel animal model exposure studies. This session focused on novel technologies that can be used to identify and measure obesogens/EDCs in Gulf of Mexico crude oils, dispersants and extracts thereof. With knowledge of the most potent oil/ dispersant derived compounds, targeted measures can be developed to mitigate their effects. Combined with epidemiology and other human health resources, these novel technologies promise a healthier environment for humans and other Gulf inhabitants – Lou's vision and his living legacy.

Lessons in Designing, Conducting and Interpreting Biodegradation and Toxicity Studies on Crude and Refined Oils

Assessing the biodegradation and hazards associated with petroleum products is challenging due to the complex nature of these substances. This course, aimed at individuals interested in environmental fate and effects of oil and oil dispersants, shared practical experience gained and lessons learned in designing, conducting, and interpreting biodegradation and toxicity studies with physically and chemically dispersed oils, including:

- Overview of petroleum substance types, uses and composition, and how weathering alters the composition upon release to the environment
- Use of chemical dispersants in oil spill response: principles & testing considerations
- · Lessons learned in conducting biodegradation studies on chemically and physically dispersed oils
- Principles of toxicity assessment of single dissolved hydrocarbon components
- Principles of multicomponent dissolution behavior in water accommodated fractions (WAF) of dispersed oils
- Coupling toxicity and WAF modeling approaches (PETROTOX model)
- · Review of common toxicity test approaches used in hazard assessment of petroleum substances
- · Guiding principles for evaluating, designing, and interpreting oil toxicity studies
- · Introduction to higher tier models used for risk assessment

Status and Plans for Coastal & Ocean Observing Systems of the Gulf of Mexico

The GoMRI Research Board Observing Systems Committee used this open meeting to inform a further series of focused workshops to stimulate questions and discussions of these topics, identify additionally needed observational parameters and their frequency of collection, and to facilitate advancing those efforts in the future. This committee meeting was open to the scientific community and other Gulf coast stakeholders.

Nearfield Modeling

This session brought together those interested in the near field dynamics of subsea oil spills, including academic and industrial researchers, model users and developers, and federal agencies. Following on the success of the previous Near Field Modeling Workshops, it concentrated on the five topic areas:

- Initial droplet size distribution
- Plume models (CFD and Integral Approaches)
- Hydrodynamics coupling of near field models with the local ocean circulation (including interfacing with CFD ocean models)
- Oil and gas coupling of near field models with far field transport models (generally, Lagrangian Particle Tracking models)
- Bubble and droplet scale fate modeling (equations of state, dissolution, and biological decay)

Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) – Informational Meeting

This workshop was led by Rebecca Green, BOEM (Organizer); Jeff Gleason, USFWS; Meg Lamont, USGS; and Keith Mullin, NOAA.

The new GoMMAPPS study is being developed as a partnership program to improve information about protected species and provide a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in Gulf offshore waters. The overarching objective of GoMMAPPS is to conduct repeated, broad-scale surveys over multiple years to determine seasonal abundances and distributions using aerial and ship-based assets, tag telemetry studies, and other research tools. The program is modeled after the successful Atlantic Marine Assessment Program for Protected Species (AMAPPS) which is now in its 2nd phase. This first planning year of GoMMAPPS is devoted to developing the strong partnerships and well-considered science framework required to collect this comprehensive dataset in the Gulf of Mexico.

A first informational and public outreach meeting was held during the GOMOSES Conference and brought together an audience of approximately 100 people. The goal of the meeting was to provide overview presentations and a forum for an interactive discussion regarding the evolving program, science considerations, coordination with other Gulf programs, and incorporation of stakeholder input. The 2-hour session was composed of various presentations, including a GoMMAPPS Overview and program perspectives on each of the target resources: marine mammals, sea turtles, and seabirds. Additionally, related program presentations were provided by the Marine Mammal Commission, the Ocean Conservancy, and several academic institutions. The evolving GoMMAPPS program provides a major opportunity for leveraging and bringing new partners to the table to strengthen the program. The project team will continue to actively engage various Gulf stakeholders and the community to ensure that GoMMAPPS best meets our common goals for a healthy and productive Gulf ecosystem.

Overview and Status of Science Action Network

The Science Action Network will enable increased cross-disaster preparedness and will support response decision-making through novel academic-agency partnerships, resource sharing, and coordination of scientific input. A leadership council composed of representatives from federal response agencies, relevant industry and NGO stakeholders, and academic institutions guides the Network. The goals are to: bridge cultural gaps between response agencies, industry, and academic scientific research through novel academic-agency partnerships and interdisciplinary scientific research through novel academic-agency partnerships and funding opportunities; and catalyze cross-disaster and cross-institutional scientific exchange.

State-of-Science for Dispersant Use in Arctic Waters

This initiative has produced a database of peer-reviewed literature from 2008-current. Over 50 scientists have determined what we KNOW and what is UNCERTAIN about dispersant use into 5 topic papers: (1) Effects & Efficacy, (2) Physical Transport and Chemical Behavior, (3) Degradation and Fate, (4) Toxicity and Sublethal Impacts, and (5) Public Health and Food Security. This meeting gave an overview of this initiative; the next step will be public input.

Environmental Disasters Data Management (EDDM)

This meeting provided an update on the EDDM working group's activities this year. Three working groups have been developed to address the goals and outcomes on these topics: Common Data Model, Field Protocols and Training, Gold Standard (including vocabularies, interoperability, QA/QC, baseline data).

GRIIDC Workshops

- Introduction to GRIIDC
- Data Managers Luncheon
- GRIIDC Data Submission
- GRIIDC Data Organization

APPENDIX III: PRESS COVERAGE SUMMARY REPORT

Mechanisms Accomplished: Conference Media Plan

- · Created and updated media section on the Conference website
- Created targeted media lists
- Created, distributed & pitched media alerts, pitches and press releases through email and Business Wire
- · Received media inquiries and facilitated media interviews
- · Promoted Conference on social media accounts
 - Continued Conference *Facebook* and *Twitter* accounts
 - Hashtags: #gulfscienceconference; #OneGulf
- Developed key message document specific to the Conference
- · Determined Conference "hot topic" science sessions and pitched to media
- · Provided a Press Room (media work room and quite interview space) for media attendees

QUANTIFYING SUCCESS:

News media attendance:

• 10 members of news media registered

News media outlets represented, include: The Tampa Tribune, WGCU (local NPR affiliate), WTUL News and Views, HarperCollins, and the Florida Specifier.

News coverage:

Searches through Business Wire and Google News returned 291 examples of coverage before, during, and after the meeting. The coverage includes stories in newspapers & magazines; on radio & television; and on various Internet sites, including blogs & press-release aggregators.

Total Circulation

To date, total circulation for the event is 145,250,232.

Social Media Statistics

- Twitter account: 192 Followers
- Twitter hashtag (#gulfscienceconference; #OneGulf) use: 214
- Facebook: 190 Followers

For further information, please contact Leslie Smith at lsmith@oceanleadership.org or 202.787.1613.

Date	Publication Name	Headline	Circulation
1/20/2016	<u>BusinessWire</u>	Innovative Scientific Research to be Released at Upcoming Oil Spill & Ecosystem Science Conference	1,514,996
1/22/2016	<u>Exponent</u>	Exponent Presenting: 2016 Gulf of Mexico Oil Spill and Ecosystem Science Conference	N/A
2/1/2016	<u>The Tampa Tribune</u>	Nearly 1,000 scientists in Tampa for conference on BP oil spill	790,198
2/4/2016	<u>WGCU</u>	Gulf Oil Spill Conference Held in Tampa	112,900
2/7/2016	Integrated Ocean Observing System	2016 GoMRI Oil Spill and Ecosystem Science Conference	N/A
2/19/2016	The Current	Oil Spill Conference in Tampa offers research opportunities for students	2,500

